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(54) **Containment of hazardous fluids**

(57) In the containment of hazardous fluids, e.g. a fluid born microorganism, wherein the hazardous fluid is placed within sealed microcontainers (10), preferably capillary tubes, a multiplicity of such microcontainers is placed within a sealed secondary container (12) and surrounded by a capture medium (14) which detoxifies the hazardous fluid in the event of rupture of or leakage from one of the microcontainers (10). The capillary tube may be sealingly pinched at intervals (16) lengthwise of the tube to provide isolated tube sections, which may then be separated to form microcapsules containing the fluid.

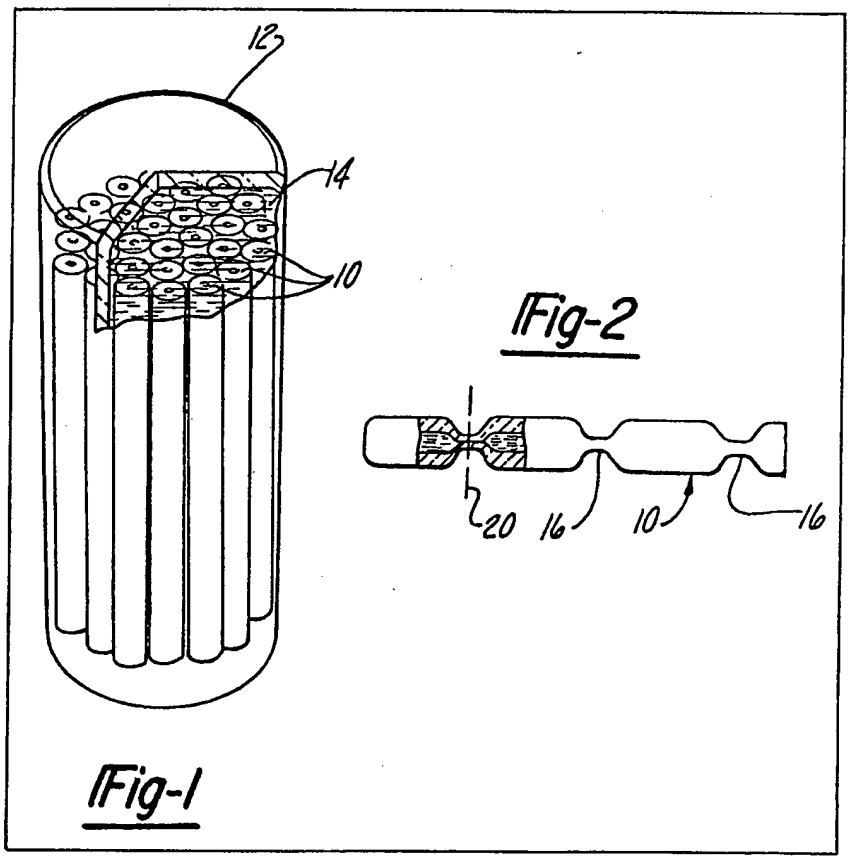

Fig-1

Fig-2

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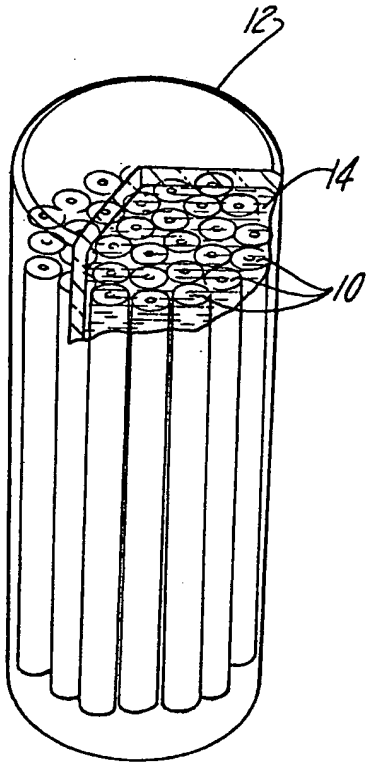

Fig-1

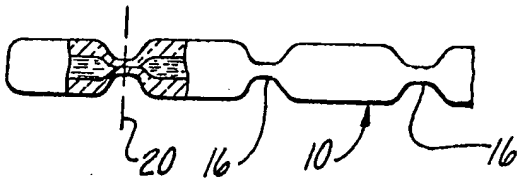

Fig-2

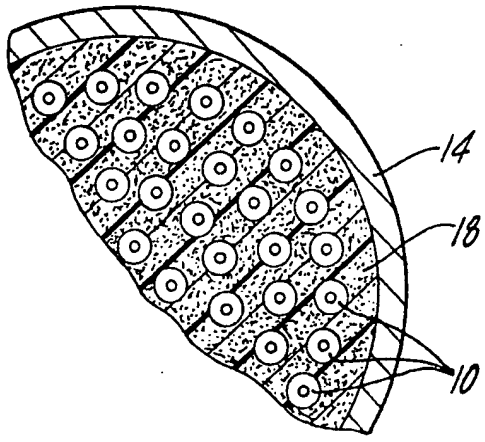

Fig-3

SPECIFICATION

Containment of hazardous fluids

The present invention relates to fluid containers and more particularly to methods and systems for storage and/or transport of hazardous fluids such as microorganisms or gases.

An object of the present invention is to provide an economical, efficient and safe method and system for containment of hazardous fluids for storage and/or transport.

In furtherance of the foregoing, another object of the invention is to provide a system and method of fluid containment which embody a number of back-up safety factors for reducing the possibility of leakage to the environment in the event of failure of any one level of containment.

Yet another object of the invention is to provide an improved method of microencapsulating fluids, and a resulting microencapsulated-fluid product.

In summary, the present invention contemplates multiple primary fluid containers carried within a sealed secondary container and surrounded within the secondary containers by a capture medium for reacting chemically with any hazardous fluid and rendering such fluid harmless in the event of leakage or rupture of a primary container. The primary containers preferably comprise sealed microcontainers, such as capillary tubes, of glass, metal or polymeric (plastic) material. The capture medium is selected in accordance with the hazardous fluid in question, and may comprise a suitable germicide, for example, where the hazardous fluid is a fluid-born microorganism or a suitable chemical reaction medium where the hazardous fluid comprises a gas. Where the fluid is a gas, the capture medium may additionally comprise a gas dispersion and flow retardant medium such as an open cellular foam structure or microscopic packing elements.

In accordance wtih a further aspect of the invention wherein the microcontainers comprise capillary tubes, the capillary tube primary containers may be sealingly crimped or pinched at periodic intervals along their lengths. This not only provides an added measure of safety by reducing the amount of leakage in the event of fracture of any one capillary tube segment, but also provides an economical method for manufacturing microencapsulated fluids by separating the sealed tube segments.

The invention, together with additional objects, features and advantages thereof, will be best understood from the following description, the appended claims and the accompanying drawings, in which:—

Fig. 1 is a partially sectioned perspective view of a hazardous fluid containment system in accordance with one embodiment of the invention;

Fig. 2 is a fragmentary partially sectioned elevational view of a fluid-containment capillary tube in accordance with a modified embodiment of the invention; and

Fig. 3 is a fragmentary sectioned plan view of a containment system in accordance with another modified embodiment of the invention.

As used in the present application and claims, the term "microcontainer" is intended to connote a container which encloses or is adapted to enclose only a minute quantity of hazardous fluid several orders of magniture less than the volume of the secondary container. The advantage of employing microcontainers of this type is that fracture or rupture of any one or a few containers does not result in escape of substantial hazardous fluid. Thus, the term "capillary tube" refers to tubes having a small inside diameter, and not necessarily to tubes filled by capillary action, although such filling technique may be employed where desired. Hollow spherical shells or microspheres may also be advantageously employed as microcontainers in accordance with the invention, particularly in the case of some gaseous hazardous fluids.

Fig. 1 illustrates a fluid containment system in accordance with the invention as comprising a multiplicity of primary microcontainers 10 enclosed within a sealed secondary container 12 and surrounded within container 12 by a fluid capture medium 14. Each primary container 10 comprises a capillary tube sealed at both ends and filled with the hazardous fluid in question. Medium 14 is of a nature to "capture" the hazardous fluid within container 10 by chemical reaction therewith in the event of rupture or fracture of one or more containers 10. For example, where the hazardous fluid comprises a microorganism carried by a suitable life-support fluid medium, capture fluid 14 may comprise a suitable germicide toxic to the microorganism. In the case of hazardous gases, the capture medium may comprise a liquid or gas adapted to react with the hazardous gas to form a harmless fluid or solid reaction product. Primary containers 10 and secondary container 12 may be constructed of any suitable glass, metal or plastic material that is inert and substantially impermeable to both the hazardous material in question and the capture medium under contemplated storage and/or transport conditions of temperature and pressure, etc.

It will be appreciated that the method and system for containment of hazardous fluids described above provides a number of significant advantages. Perhaps most significantly, the invention provides three levels of safety. Provision of multiple primary microcontainers insures that only a small amount of the hazardous fluid will be exposed to the capture medium in the event of fracture of any one container. This advantage may be further enhanced by the modification illustrated in Fig. 2 wherein the capillary tube microcontainers 10 of Fig. 1 are sealingly pinched or crimped at periodic intervals 16 along the tube length. Such pinching insures that, in the event of fracture, only a small quantity of hazardous fluid will be released. Of course, if the fracture is at a neck 16, no hazardous fluid will be released. Indeed, the periodic crimps may operate as

fracture points for promoting rupture only at predefined and safe locations lengthwise of the tube in the event of bending stresses during handling, etc.

Provision of a capture medium surrounding the primary microcontainers provides a second level of safety in accordance with the invention. Any hazardous fluid which escapes from the primary containers will be rendered harmless by chemical reaction (including detoxification in the case of microorganisms) within the capture medium. In the case of hazardous gases, it is contemplated that the capture medium may contain a gas dispersion medium in addition to a reactive fluid for retarding migration of the hazardous gas. Such dispersion medium may comprise an inert open-cell foam 18 as shown in Fig. 3 into which the reaction fluid is impregnated, or may comprise an aggregate of individual microscopic beads or shells of glass, plastic or metal surrounded by the reaction fluid. Such foam or aggregate-foam filler additionally serves to prevent or retard propagation of shock waves to the primary containers. Primary microcontainers 10 and secondary container 12 may be filled and sealed (and crimped) according to conventional techniques.

The modification of Fig. 2 is also useful in accordance with another important aspect of the invention in manufacture of microencapsulated fluid pellets. That is, any suitable fluid, such as antibodies, vitamins, enzymes, etc., may be fed into the capillary tube which is then sealed and crimped as previously described. The crimp-encapsulated fluid-separated segments may then be severed, as along the line 20 in Fig. 2, to form separate capsule fluid containers. It will be appreciated that the crimping and severing operation may be performed in a single step. In such application, tube 10 would be of soluble or permeable material calculated to release the contained fluid in the desired fashion.

CLAIMS

1. A system for containing hazardous fluids and the like comprising a multiplicity of sealed microcontainers each enclosing a preselected fluid to be contained, a sealed secondary container enclosing said multiplicity of microcontainers and a capture medium surrounding said microcontainers within said secondary container and adapted to react chemically with said preselected fluid in the event of rupture of one of said microcontainers for reducing the hazardous quality of said fluid.

2. The system set forth in claim 1, wherein said preselected fluid comprises a microorganism carried by a life-sustaining fluid medium, and wherein said capture medium comprises a germicide toxic to said microorganism.

3. The system set forth in claim 1 or 2, wherein said capture medium comprises a foam-like structure permeable to said preselected fluid surrounding said members.

4. The system set forth in claim 1, 2 or 3, wherein said microcontainers comprise a plurality of tubular sealed capillary members each including a multiplicity of isolated hollow segments sealing separated from each other lengthwise of said members by a corresponding multiplicity of integral member neck portions of reduced dimension.

5. A method of containing a hazardous fluid for storage or transport comprising the steps of:

(a) encapsulating quantities of said hazardous fluid in corresponding microcontainers,

(b) immersing a multiplicity of said microcontainers within a secondary container in a capture medium adapted to react chemically with said hazardous fluid for reducing the hazardous nature thereof, and then

(c) sealing said secondary container to enclose said multiplicity of microcontainers and said capture medium.

6. A method of containing a fluid within a multiplicity of individual microcapsules comprising the steps of:

(a) filling a tubular member with said fluid,

(b) sealingly crimping longitudinally spaced segments of said tubular member to provide a multiplicity of isolated tubular sections physically attached but fluid-separated from each other, and

(c) separating said segments to form a multiplicity of individual microcapsules each sealingly containing said fluid.

7. A system as claimed in claim 1 substantially as hereinbefore described with reference to and as illustrated in any one of the accompanying drawings.

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